Baseline MVA at the Bell Creek CO_2 Enhanced Oil Recovery Project

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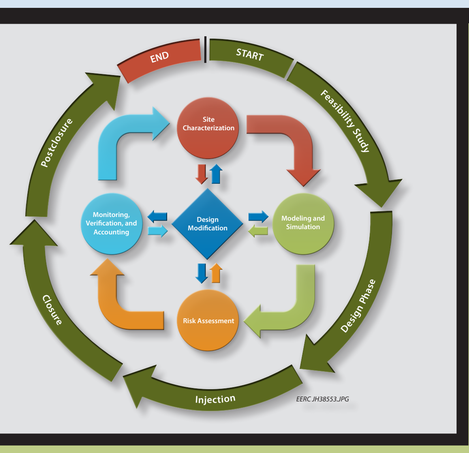
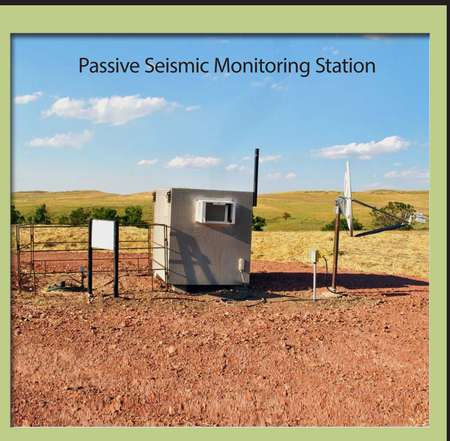
Abstract

The Plains CO_2 Reduction (PCOR) Partnership, led by the Energy & Environmental Research Center (EERC), is working with Denbury Resources Inc. to determine the effect of large-scale injection of carbon dioxide (CO_2) into the lower Cretaceous Muddy Formation (depth, 4500 ft) for the simultaneous purpose of CO_2 enhanced oil recovery (EOR) and to study incidental CO_2 storage at the Bell Creek oil field, which is operated by Denbury Onshore LLC.

The activities at Bell Creek will inject approximately 1 million tons of CO_2 annually. The Bell Creek demonstration project is a unique opportunity to develop a set of cost-effective monitoring, verification, and accounting (MVA) protocols for large-scale (>1 million tons/year) CO_2 EOR and to study incidental CO_2 storage in a clastic formation. Developing cost-effective approaches to predict and determine the fate of injected CO_2 is an important aspect of implementing large-scale carbon capture and storage (CCS) technology.

The goal of the MVA program is to provide critical data to verify site security, evaluate reservoir behavior during the injection program, determine the ultimate fate of injected CO_2, and investigate mechanisms that affect CO_2 storage efficiency within the EOR process all while operating in an integrated and compatible manner alongside the commercial CO_2 EOR operation. The MVA program utilizes targeted time-lapse data acquisitions as part of a surface-, near-surface-, and deep subsurface-monitoring program guided by key subsurface technical risk, geologic characterization, and predictive simulation results. In addition to developing a robust, site-specific MVA data set, the MVA program will also provide complementary data to the commercial operator because of the natural overlaps that exist between MVA and EOR data sets.





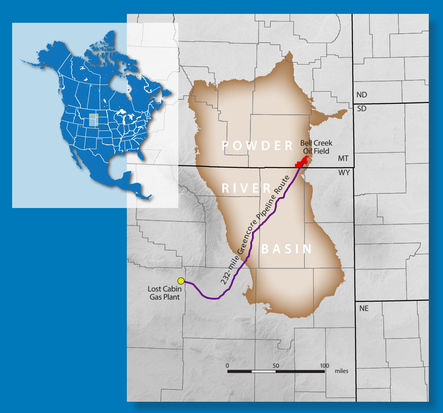
The deep subsurface MVA program utilizes a combination of wellbore and geophysical technologies to:

- Access storage/flood performance and efficiencies.
- Provide assurance monitoring
- Track the vertical and lateral extent of fluid and CO_2 movements during the injection process.
- Account for injected CO_2.

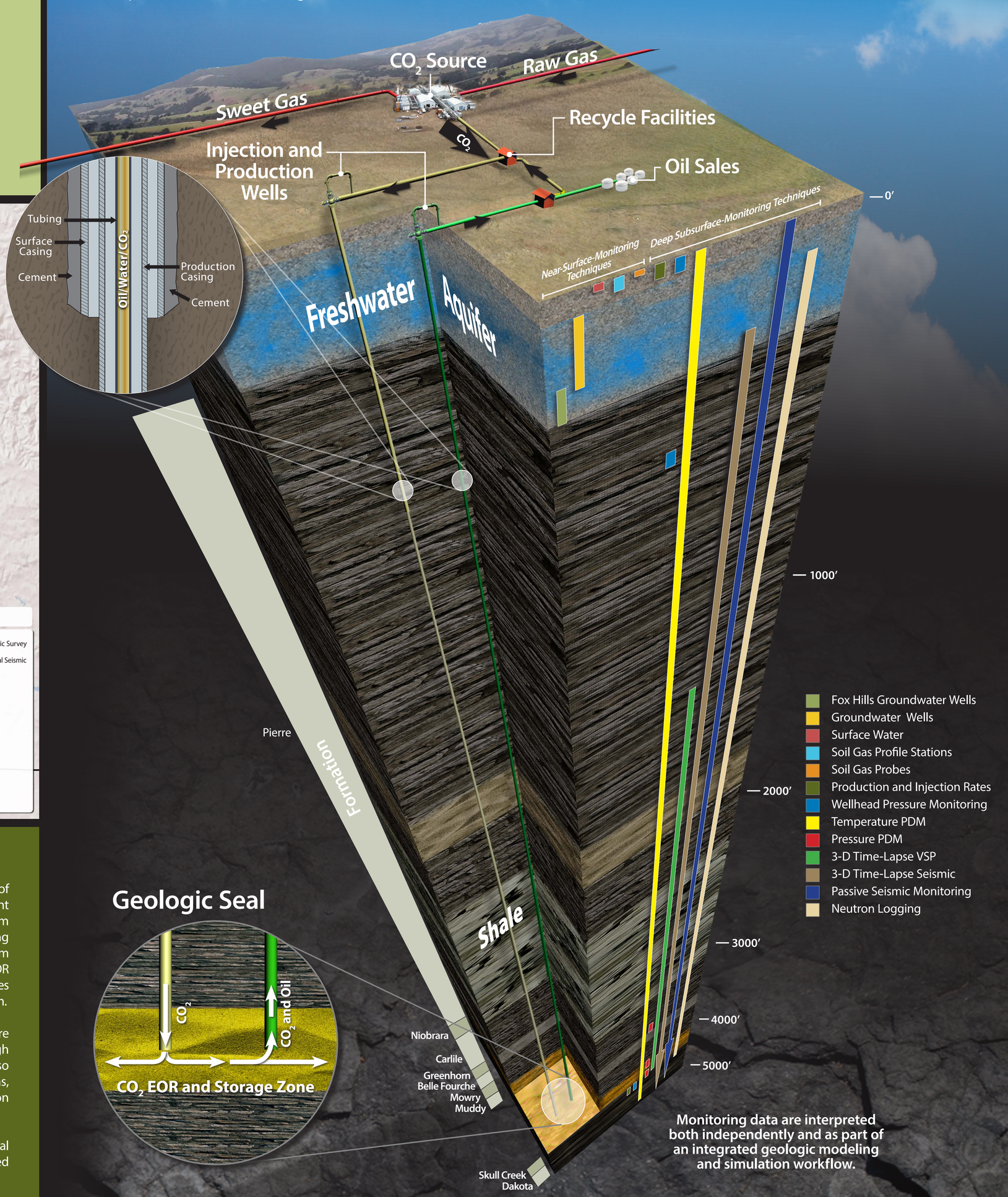
Surface water sample collection.

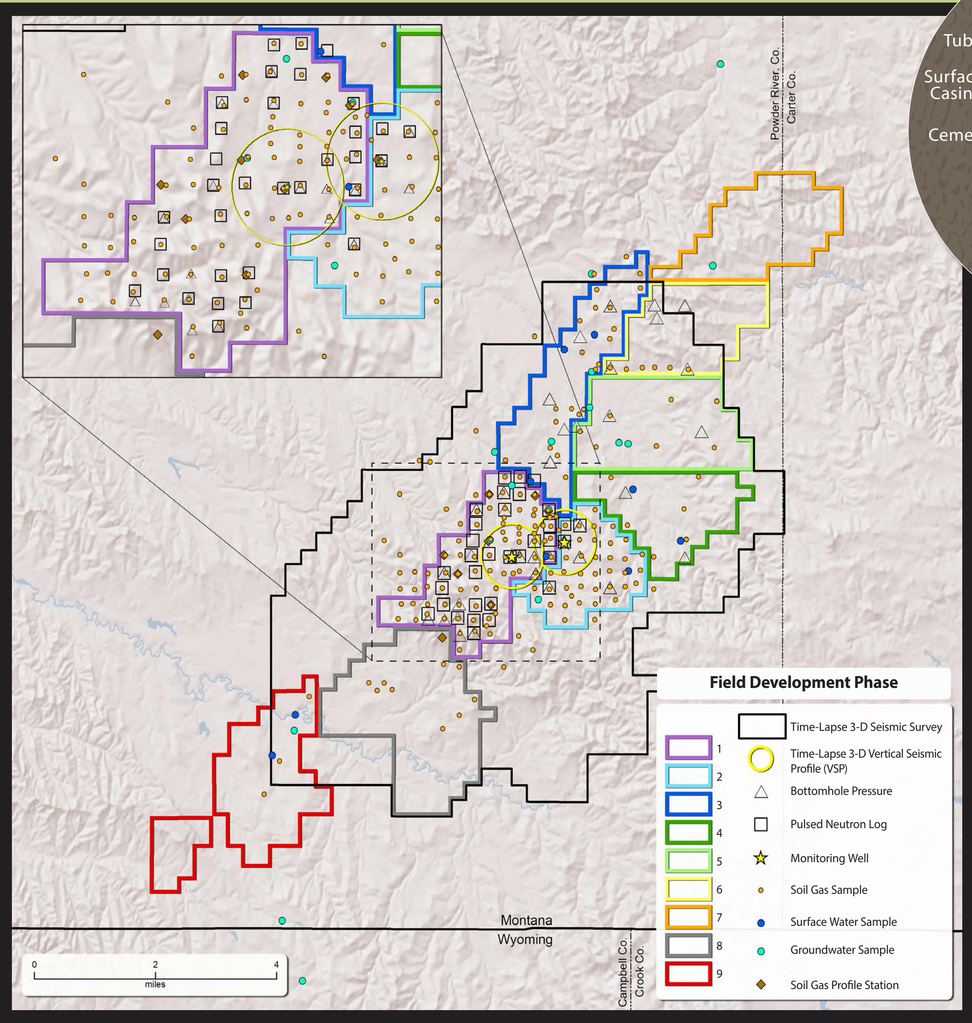
Soil gas sample collection at a semi-permanent soil gas profile station.

Groundwater sample collection at a stock well.



A robust baseline soil gas- and water-sampling program allows for scientific assessment of naturally occurring CO_2 in the near-surface environment. The purpose of the near-surface-monitoring program is twofold: 1) to establish baseline conditions for soil gas and water chemistries present in surface water, soil, and shallow groundwater aquifers in the vicinity of the CO_2 injection site and 2) to provide a source of data to show that surface environments remain unaffected by fluid or gas migration and/or to identify the source and quantify the impact of an out-of-zone migration event should it occur.





Monitoring data are interpreted both independently and as part of an integrated geologic modeling and simulation workflow.

Summary

No single technology exists that is capable of effectively monitoring the lateral and vertical extent of CO_2 throughout the stratigraphic column in both the near-wellbore and interwellbore environment for all storage sites. For this reason, the PCOR Partnership has designed a monitoring program specific to the needs of the Bell Creek Field that monitors a variety of physical phenomena utilizing several commercially viable technologies and techniques. These technologies, as deployed from April 2010 to May 2013, include geophysical surveys, a variety of wireline-deployed technologies, EOR operations data, and traditional groundwater- and soil gas-monitoring techniques. These technologies were used to collect a baseline data set for use during the injection-monitoring phase of the program.

The specific technologies selected are also designed to operate in a complementary manner where an anomalous signal from one monitoring technique can be investigated and characterized through the use of one or more of the remaining techniques. Additionally, the PCOR Partnership is also evaluating each of these monitoring technologies in order to understand the benefits, limitations, and challenges (including those unique to EOR) of each technology when deployed in conjunction with a commercial CO_2 EOR operation from both an operational and technical standpoint.

Ultimately, the baseline MVA program is designed to provide complementary data to the commercial EOR operation and to understand the processes of long-term incidental storage of CO_2 associated with EOR operations.

References

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